WHAT IS CLAIMED IS:

1. An optical switch comprising:

a first optical waveguide through which light propagates;

a second optical waveguide arranged at a position where optical crossing occurs with respect to the first optical waveguide, through which light propagates;

a first lead electrode arranged along the first and the second optical waveguides;

a pair of first control electrodes arranged along the first optical waveguide so as to face each other, with the crossing portion put therebetween, to which a control voltage controlling the crossing state is applied via the first lead electrode;

a second lead electrode arranged so as to face the first lead electrode; and

a pair of second control electrodes arranged along the second optical waveguide so as to face each other, with the crossing portion arranged therebetween, to which the control voltage is applied via the second lead electrode.

2. The optical switch according to claim 1, wherein the first and the second lead electrodes are arranged so as to face each other, with the first and the second optical waveguides arranged therebetween.

3. The optical switch according to claim 2, wherein the first and the second lead electrodes are arranged substantially parallel with each other.

4. The optical switch according to claim 1, wherein the first and the second optical waveguides are arranged in a physically solid crossing state.

5. The optical switch according to claim 1, wherein the crossing portion constitutes a $2 \times 2$ multi-mode interference coupler.

6. The optical switch according to claim 1, wherein the crossing portion constitutes an X crossing waveguide.

7. The optical switch according to claim 1, wherein the first and the second optical waveguides are arranged in the crossing portion, substantially in parallel with and close to each other.

8. The optical switch according to claim 7, wherein a gap between the first and the second optical waveguides in the crossing portion is narrower than a gap between the first and the second optical waveguides in portions other than the crossing portion.

9. The optical switch according to claim 7, comprising first and second chirp control electrodes arranged so as to face each other along the first and the second optical waveguides in the crossing portion, wherein a chirp control voltage is applied to the first and the second chirp control electrodes for controlling chirp of light output from either of the first and the second optical waveguide.

10. The optical switch according to claim 1, wherein each of the first and the second control electrodes has a control electrode piece divided into a plurality of parts in the longitudinal direction.

11. The optical switch according to claim 10, wherein each of the first and the second optical waveguides has a PIN structure in which an I-core layer is put between a P-cladding layer and an N-cladding layer, in regions other than the regions immediately below the control electrode pieces, which are adjacent to each other in the longitudinal direction, wherein corresponding control electrode piece is deposited on the P-layer,

the optical waveguide immediately below a region between the control electrode pieces adjacent to each other in the longitudinal direction has a structure in which the P-layer is removed from the PIN structure, and

the N-layer in the PIN structure is a common layer to the first and the second optical waveguides.

12. The optical switch according to claim 1, wherein each of the first and the second optical waveguides has the PIN structure of a three-layer type, and the first and the second control electrodes are deposited respectively on the P-layer of the first and the second optical waveguides, and

the first and the second optical waveguides have a common N-layer.

13. The optical switch according to claim 1, wherein each of the first and the second optical waveguides has the PIN structure of a one-layer buried type, and the first and the second control electrodes are deposited respectively on the I- layer of the first and the second optical waveguides, and

the first and the second optical waveguides have a common N-layer.

14. The optical switch according to claim 1, further comprising a directional coupler type optical attenuator having

a third optical waveguide formed by extending at least one of the first and the second optical waveguides;

a fourth optical waveguide arranged in parallel with and close to the third optical waveguide, so that optical coupling occurs between the third and the fourth optical waveguides; and

a third control electrode arranged along the fourth optical waveguide, to change the refractive index of the core layer by applying

an electric field to the core layer in the fourth optical waveguide.

15. The optical switch according to claim 1, comprising a directional coupler having first and second ports, wherein light output from either of the first and the second optical waveguides is controlled to be output from either of the first and the second ports, by changing an external voltage.

16. The optical switch according to claim 1, comprising a directional coupler having first and second ports, wherein light output from either of the first and the second optical waveguides is guided to the first and the second ports to control the output ratio between the respective first and second ports.

17. An optical communication system comprising an optical switch including

a first optical waveguide through which light propagates;

a second optical waveguide arranged at a position where optical crossing occurs with respect to the first optical waveguide, through which light propagates;

a first lead electrode arranged along the first and the second optical waveguides;

a pair of first control electrodes arranged along the first optical waveguide so as to face each other, with the crossing portion put therebetween, to which a control voltage controlling the crossing state

is applied via the first lead electrode;

a second lead electrode arranged so as to face the first lead electrode; and

a pair of second control electrodes arranged along the second optical waveguide so as to face each other, with the crossing portion arranged therebetween, to which the control voltage is applied via the second lead electrode.

18. A semiconductor optical modulator comprising:

a first optical directional coupler on a semiconductor substrate;

a second optical directional coupler on said semiconductor substrate;

a first optical waveguide;

a second optical waveguide;

a wave-coupling region for the first waveguide and the second waveguide between the directional couplers;

a pair of traveling-wave electrodes, said traveling-wave electrodes having no crossover; and

two sets of air-bridge structures forming connections between the waveguide region and the traveling-wave electrodes.

19. The optical modulator according to claim 18, wherein the wave-coupling region includes an optical waveguide crossover.

20. The optical modulator according to claim 18, wherein the optical waveguides have proximate regions formed of P-I-N structures on a conductive semiconductor layer, the proximate regions operating as directional couplers controlled by bias voltages supplied to a waveguide electrode provided through a traveling wave electrode to switch optical signals propagating through the waveguides to each other and wherein the first directional coupler is cascaded with the second directional coupler through the waveguide coupling region.

21. The optical modulator according to claim 19, wherein the traveling wave electrodes are operative to propagate high-speed electronic signals from a signal input pad to the waveguide electrodes through the air-bridge structures.

22. The optical modulator according to claim 20, wherein the first pair of electrodes or the second pair of electrodes on the optical waveguides are divided and disposed along a longitudinal axis, wherein each electrode is connected by the air-bridge structures individually to the outer traveling-wave electrode.

23. The optical modulator according to claim 21, wherein the optical waveguide is a ridge waveguide.

24. The optical modulator according to claim 22, wherein the optical waveguide employs a ridgeless waveguide structure.

25. The optical modulator according to claim 22, wherein the optical waveguide is a buried hetero-structure (BH) waveguide.

26. The optical modulator according to claim 22, wherein the wave coupling region is coupled to said directional coupler with a cross state.

27. The optical modulator according to claim 22, wherein the wave coupling region is a 2 $\times$ 2 multi-mode interference (MMI) coupler.

28. The optical modulator according to claim 22, wherein the wave coupling region is an X waveguide.

29. The optical modulator according to claim 22, wherein divided electrodes are electrically isolated from each other.

30. The optical modulator according to claim 22, wherein one bias electrode is disposed at least on the conducting layer on the semiconductor substrate.

31. The optical modulator according to claim 22, wherein structure of said optical modulator comprises Type III-V compound materials.

32. The optical modulator according to claim 22, wherein structure of said optical modulator comprises type IV compound materials.